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A Prospective Longitudinal Study of Phonological Development in Late Talkers

A. Lynn Williams
East Tennessee State University, Johnson City
Mary Elbert
Indiana University, Bloomington

With recent federal legislation, Public Law 99-457 and Individuals With Disabilities Education Act Part H, there has been increased interest among researchers, clinicians, and parents for the early identification and treatment of young children who have been described as "late talkers." This increased interest has led to a number of studies on these children in the past few years (Paul & Jennings, 1992; Paul, Spangle-Looney, & Dahm, 1991; Rescorla & Ratner, 1996; Rescorla & Schwartz, 1990; Stoel-Gammon, 1989; Whitehurst, Fischel, et al., 1991; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). These investigations have provided an expanded database on the late talker population as well as a normative database on typically developing children younger than 3 years of age.

Although several investigations have demonstrated that late talkers exhibit expressive language delay with or without receptive language delays (cf., Fischel, Whitehurst, Caulfield, & DeBaryshe, 1989; Pharr, Ratner, & Rescorla, 2000; Rescorla & Goossens, 1992; Rescorla & Schwartz, 1990; Whitehurst, Fishel, et al., 1991), two distinguishing characteristics of these young children are a limited lexicon and restricted phonological abilities (Paul, 1991; Paul & Jennings, 1992; Stoel-Gammon, 1991). These distinguishing characteristics have prompted several studies that have described the phonological abilities of late talkers, as well as studies that have examined the phonological abilities of late talkers in relation to specific domains in expressive language, such as lexicon size and early syntactic abilities. Many of these investigations have attempted to identify

ABSTRACT: **Purpose:** This study involved prospective longitudinal data on 5 late talkers to provide information about the course of phonological development in order to identify possible predictors of delayed versus deviant development.
Method: Five children (3 boys, 2 girls) were identified as late talkers and divided into a younger group and an older group. Each child was followed monthly for 10 to 12 months (22–33 months for the younger group and 30–42 months for the older group). Two types of monthly language samples (free play and elicited) were obtained to describe the individual courses of phonological development for each child. Independent and relational analyses were completed at each age to describe word-initial and word-final phonetic inventories, syllable structure, syllable diversity, percentage of consonants correct (PCC), sound variability, and error patterns.
Results: The results indicated that 3 of the children resolved their late onset of speech by 33 to 35 months of age. In addition to quantitative factors, (e.g., limited phonetic inventory, lower PCC, and more sound errors), qualitative variables (e.g., atypical error patterns, greater sound variability, and slower rate of resolution) also were identified as potential markers of long-term phonological delay.
Clinical Implications: This study provides information to clinicians so they can identify those children who are less likely to resolve their late onset of phonological development without direct intervention. Procedures are described for assessing early linguistic behaviors that incorporate independent and relational analyses on more extensive speech samples (elicited and free play). From these analyses, clinicians can examine quantitative and qualitative variables to differentiate phonological delay from deviance.

KEY WORDS: late talkers, phonology, phonological outcomes, phonological development

potential predictor variables that may help distinguish, at an earlier age, children who will "outgrow" their delay from children who will require intervention. In addition, studies have reported links between early linguistic development and later academic success (Catts, 1993; Kamhi & Catts, 1989). Studies in the last category demonstrate the importance of identifying potential predictor variables in order to provide data for speech-language pathologists in determining as early as possible which children would "catch up" with their age peers and those who would not without direct intervention. Studies in each of these areas will be reviewed in the following sections.

PHONOLOGICAL ABILITIES OF LATE TALKERS

Stoel-Gammon (1989) examined the early prespeech behaviors of late talkers in a longitudinal study. Specifically, she examined the relationship between babbling and the onset of first words in 2 late talkers. These children were part of a larger longitudinal study of normal phonological development from 9 months to 24 months of age (Stoel-Gammon, 1985). The 2 late talkers did not produce the required 10 different adult words until 24 months of age, whereas 70% of the other children had reached the meaningful speech stage by 18 months and the remaining children by 21 months. In addition to the late onset of first words, Stoel-Gammon reported that the babble of the late talkers was different than that of the other children in that few canonical babbles were produced from 9 to 21 months. At 24 months, when both children achieved the meaningful speech stage, their phonetic inventories were more limited and they produced simpler syllable structures as compared to their peers.

Stoel-Gammon (1991) discussed potential "red flags" in phonological development that may signal normal from disordered development. At 24 months of age, these included numerous vowel errors, widespread deletion of initial consonants, substitution of glottal consonants or [h] for a variety of consonants, substitution of back consonants for front consonants, and deletion of final consonants. Stoel-Gammon based this preliminary identification of atypical phonological development on her investigations of normal acquisition in typically developing toddlers.

Paul and Jennings (1992) examined phonological development in a semi-longitudinal study of 28 toddlers with slow expressive language development (SELD) compared to a control group of normally developing toddlers. Phonological development was examined by dividing the SELD children into younger (18–23 months) and older (24–34 months) groups and comparing their development to two groups of control subjects who were matched for age, socioeconomic status (SES), birth order, and gender ratio. The percentage of consonants correct (PCC), phonetic inventories, and syllable structures were examined for each of the groups. Paul and Jennings found that the SELD groups produced fewer consonants correctly than did their normal developing peers (74% for peers; 56% for older SELD; 34% for younger SELD). With regard to phonetic inventories, they found that the phonetic inventories were significantly smaller for both older and younger SELD groups as compared to the control groups. Specifically, typical older subjects produced an average of 18 different consonants as compared to 10 produced by the older SELD group. For the younger children, subjects in the control group produced 13.6 different consonants as compared to 6.2 produced by subjects in the SELD group. Finally, the SELD children were found to produce less complex syllable structures as compared to their matched peers. Specifically, the late talkers primarily produced CV, VC, and CVC syllables, which contained only glottal stops, glides, or a single consonant. In contrast, the typically developing toddlers produced more complex syllables that contained more than one consonant in the CVC syllable structure.

Paul and Jennings (1992) concluded that the SELD children as a group exhibited delayed rather than deviant patterns of development when compared to the typically developing children. There are, however, several factors that may have masked their results in identifying individual differences that may suggest deviant, rather than delayed, development. First, the results were reported across the entire SELD group, which may have ignored important individual differences that could distinguish delayed versus deviant phonological development. Second, there was a wide age range within the younger and older groups. There was a 6-month age range in the younger SELD group (18–23 months) and an 11-month age range in the older SELD group (24–34 months). Such wide age ranges may miss important details of phonological development at discrete points in age. Finally, the speech samples on which the analyses were based were limited. The samples were 10 minutes in length, which raises questions about whether they were sufficient and representative of each child's phonological abilities.

Rescorla and Ratner (1996) described the phonetic profiles of a large group of late talkers at one age period in comparison to their age-matched peers. They examined the number of vocalizations, frequency of consonants and vowels in all three word positions, consonant and vowel inventories, and syllable shapes of 30 late talkers and 30 typically developing toddlers at approximately 24 months of age. Meaningful and nonmeaningful vocalizations were transcribed and tallied for the vocalizations, inventories, and syllable shapes that were collected from a 10-minute free-speech sample. Rescorla and Ratner found that the late talkers lagged behind their peers in phonetic comparisons, which supports previous reports of the presence of phonological delay in late talkers. However, similar cautions mentioned in other studies must be expressed with these results as well. The small speech samples, absence of information on individual development, and wide age range (24–31 months) limit the findings to a general description of the phonetic profiles of late talkers as "delayed" relative to their peers.

Roberts, Rescorla, Giroux, and Stevens (1998) completed a follow-up study of the late talkers reported in the Rescorla and Ratner (1996) study in order to examine the

phonological skills of the children at age 3 in comparison to age-matched typically developing peers. They found that at age 3, the expressive specific language impairment (SLI-E) group had caught up with their typically developing peers in vocalization rate, or volubility, but half of the children still lagged behind in phonetic inventory, PCC scores, and overall intelligibility. Specifically, the continuing delay group (CD) had 6.1 stable consonants in their phonetic inventory, had a PCC score of 57.4, and produced 47.9% fully intelligible utterances. In comparison, the typically developing group had a phonetic inventory of 14.5 stable consonants, had a PCC score of 89.4, and produced 81.2% fully intelligible utterances. Although Roberts et al. (1998) concluded that their findings point to delayed rather than deviant phonological development, they suggested that the CD group represents a discreet diagnostic group that has the potential for continuing difficulty.

In a more recent study, Pharr et al. (2000) examined syllable structure development in children who were typically developing in comparison to children with SLI-E at 24 and 36 months of age. They found that typically developing children at 24 months and SLI-E children at 36 months produced similar proportions of syllable structures, with the exception that the 24-month-old typically developing children produced more consonant clusters than did the 36-month-old SLI-E children. Pharr et al. further reported that SLI-E children vocalized less than their typically developing peers did at both age periods.

Thus, although there is some information about the phonological skills of late talkers, information about the *course* of phonological development in late talkers is more limited. This type of information would be beneficial in identifying those characteristics of late talkers who are delayed and therefore will recover without intervention versus those who are deviant and will require direct intervention.

LEXICON SIZE AND PHONOLOGICAL DEVELOPMENT

Several studies have indicated that late talkers have a smaller lexicon (cf., Paul, 1991; Rescorla, 1990; Thal, 1989; Whitehurst, Fischel, et al., 1991) that occurs in conjunction with slow phonological development. Lexicon size frequently has been used as inclusionary criterion for the identification of late talkers. Rescorla and her colleagues (Mirak & Rescorla, 1998; Rescorla & Fechnay, 1996; Rescorla & Goossens, 1992) defined late talkers as children whose expressive lexicon is less than 50 words at 24 months of age. Although lexicon size is a distinguishing characteristic of late talkers, their vocabulary size increases more rapidly than their phonological abilities do. Rescorla, Roberts, and Dahlsgaard (1997) also reported that by age 3, lexical development in late talkers progressed more rapidly than did syntactic and morphological development. Whitehurst, Fischel et al. (1991) and Paul (1991) reported that articulation and phonological abilities in late talkers continue to be delayed throughout the preschool period.

For children under the age of 2 years, lexicon size is less clear as a diagnostic marker for identifying late talkers. Kelly (1998) reported that the standard deviation in a child's vocabulary size has a sharp decline between 18 and 24 months of age in typically developing children. Thus, according to Paul (1996), using normal vocabulary development for children younger than 24 months of age may not be meaningful.

Ellis Weismer, Murray-Branch, and Miller (1994) described the phonological and language development of 4 late talkers who were 13–14 months of age at the beginning of their study. None of the late talkers met Stoel-Gammon's (1991) criteria for delayed phonological development at age 2. Consequently, Ellis Weismer et al. (1994) did not judge phonological abilities to be a significant factor in the children's restricted vocabularies.

In summary, although there is documented evidence that delayed lexical acquisition is a predominant characteristic of late talkers, limited information is available on lexicon size and phonological skills for children younger than 24 months. Further, there is limited information on the *course* of lexical acquisition in late talkers.

SYNTACTIC ABILITIES AND PHONOLOGICAL DEVELOPMENT

Rescorla and Schwartz (1990) reported outcome data on 25 late-talking boys who were followed at yearly intervals from around age 2 to age 4. Their data were based on a corpi of 100 utterances that were collected from half-hour naturalistic speech samples. Their focus was limited to the expressive syntactic development of these children. They reported that age and severity were predictive factors in outcome. Specifically, the older a child was and the greater the gap between expected and actual expressive language skills at intake, the poorer the outcome. Rescorla and Schwartz made an important point regarding the complexities in identifying predictive factors, which include differences in each individual child. Factors such as motivation for communication, pragmatic style, parental conversational style, presence or absence of speech therapy, presence or absence of otitis media, and the presence of articulation deficits complicated the interpretations in accounting for outcomes.

Paul (1993b) described the language and phonological development of 37 late-talking toddlers in comparison to age-matched peers in a follow-up study. She described their development from their initial intake evaluation at age 20–34 months and at 1-year intervals until they reached kindergarten (i.e., ages 3, 4, and 5). Paul found that although the majority of children moved within the normal range in phonological and language development, there were still a substantial number of children who retained deficits throughout the preschool years. She reported two factors that appeared to be predictive of developmental outcome: age and gender. Specifically, older children with continuing delays had a less likely chance for spontaneous remission. Further, boys were less likely than girls to

evidence spontaneous recovery in the area of expressive syntax. Paul cautioned interpretation of these preliminary findings and claimed they were "suggestive." Additional caution should be used given that the evaluation of general language and phonological measures (receptive/expressive vocabulary and syntax; articulation) were based on standardized testing. Naturalistic observational data were limited and were used primarily for the assessment of narrative skills and ratings of intelligibility.

IMPORTANCE OF EARLY IDENTIFICATION

Whitehurst and Fischel (1994) stated that specific language delay in toddlers is more aptly characterized as a risk factor than a disorder because many children recover to expected developmental levels by late preschool age. Ellis Weismer et al. (1994) also suggested that labels that include "delay" or "impairment" for these late talkers may be an inappropriate characterization because approximately half of these children will exhibit "developmental spurts" and catch up with their peers at age 3. Although the majority of children achieve normal developmental levels by 5 years of age, there are still those who continue to lag behind their peers when entering school and so require direct intervention. Paul (1996) found that 26% of the children she followed with SELD continued to demonstrate expressive language problems beyond age 5. A number of investigations have shown that many of these children, identified as late talkers during toddlerhood, experience later difficulties in written language and academic achievement as school-age children (Catts, 1993; Kamhi & Catts, 1989).

A number of studies also have reported on the socialization difficulties experienced by children who have speech and language impairments (cf. Hadley & Rice, 1991; Rice, Hadley, & Alexander, 1993; Rice, Sell, & Hadley, 1991). Paul (1993a, 1993b) reported that a language delay that persists into age 3 is less likely to evidence spontaneous remission during the preschool period. The need, therefore, to determine early reliable predictors of phonological outcome in delayed versus deviant phonological development will have numerous long-term social and academic benefits for these at-risk children.

To summarize, different methodologies have been used to describe the phonological development and related language abilities of late talkers. There is a growing body of information from cross-sectional, follow-up, and longitudinal studies that provide information about the phonological skills of late talkers. The large *N* (cross-sectional and follow-up) studies provide useful information about general trends or profiles in development. Longitudinal studies provide more information about individual differences in development. From both types of investigation, however, there is limited information about predictor variables that will account for developmental outcomes. Additionally, little is known about the actual *course* of phonological development and related language abilities in late talkers. Use of small speech samples, wide ranges within age periods investigated, and single observational periods limit the information that can be gained about the course and rate of phonological development in individual children. This type of information would be beneficial in identifying characteristics of late talkers who are delayed and therefore will recover without intervention versus those who are deviant and will require direct intervention. The need for early identification is demonstrated in the findings of several studies that indicate that a substantial number of children who are late talkers are at risk for later academic and socialization problems.

The purpose of this investigation is to present 10–12 months of prospective phonological data on 5 children who were identified initially as late talkers in order to examine changes in children who "catch up" as opposed to those who do not. It was hypothesized that there would be qualitative differences in addition to the quantitative lags in language and phonological skills that, if identified, could serve as reliable predictors of delayed versus deviant development. Language samples were collected on each child on a monthly basis and encompassed an age range of 22 to 42 months. These prospective data will provide information on the *course* of phonological development and related aspects of expressive language skills in 5 individual late talkers. The benefit of prospective data from repeated, monthly observation periods is that they may provide insights into the course of development of phonology and specific domains of language.

METHOD

Participants

Children were recruited through parental referral in response to fliers posted at preschools and day care centers in Bloomington, Indiana. These fliers encouraged parents of 18–36-month-old children who had concerns about their child's speech development to contact the authors regarding eligibility for this study. Five children (3 boys, 2 girls) qualified as late talkers and participated in this study. The participants were divided into a younger group and an older group. Two of the children were 22 months old at the beginning of the study and were followed until age 33 months. Three children were 30–31 months old at the beginning of the study and were followed until 40–42 months of age. Therefore, the ages examined in this study encompass a 20-month age range from 22 to 42 months. The children are discussed in terms of the younger group (Y) who caught-up (C) with their age peers (YC1 and YC2) and the older group (O), of whom only 1 child resolved her delay (OC3) by the end of the study and 2 children did not catch up (N) with their age peers (ON4 and ON5). Children were considered to have caught up, or resolved their phonological delay, when their phonetic inventories, syllable structures, and PCC were similar to their chronological-age peers by 33–35 months of age.

Children were identified as late talkers on the basis of lexical and phonological skills. Specifically, all children met the following criteria:

- produced fewer than 50 words in their expressive vocabularies at 22 months of age or older and few, if any, word combinations, according to parental report (cf., Paul, 1993b; Rescorla & Schwartz, 1990);
- exhibited limited sound inventories that included less than 12 sounds at 22 months (Stoel-Gammon, 1985) and less than 15 sounds at 31 months (Prather, Hedrick, & Kern, 1975);
- reported no unusual prenatal, sensory, cognitive, or developmental concerns in the parental case history;
- possessed no known history of organic or motor disorders as assessed by informal observations and case history;
- had normal hearing abilities as determined by sound field testing at 25 db; and
- resided in a monolingual English-speaking family.

Although all children presented with normal hearing abilities at the time of enrollment in the study, it should be noted that 2 of the children in the older group (ON4 and ON5) had histories of frequent ear infections. None of the other children had reported histories of ear infections.

Table 1 summarizes the participants at the beginning of the study. Their age, number of words produced, and presence of any combinatorial utterances at the initial observational session are listed.

Procedures

Data were collected from each child on a monthly basis. Each monthly observation session consisted of a 45–60-minute visit to the Indiana University Speech and Hearing Clinic. Observations were made in a laboratory playroom designed for participant testing and data collection. Audio- and videotape recordings were made of parent–child or clinician–child interactions during each session. A Sony electret microphone was inserted into a pocket of a tabard worn by the child and was attached to a Technic Panasonic tape recorder. A 25-foot cord connected the microphone to the tape recorder, which allowed the child to move about the room.

Two types of speech samples were collected during each observation period. A naturalistic speech sample was gathered during a 30–40-minute free-play interaction between the child and parent and/or the child and clinician. The average number of utterances produced in each session by the children was 288.94 (younger group = 257.15; older group = 320.73). The toys remained constant across subjects and across observation periods. In addition to the spontaneous speech sample, children were provided opportunities to name toys and items, which represented words that contained all English sounds in word-initial (WI) and word-final (WF) positions. Children of this age actively select and avoid words that contain sounds that are IN and OUT of their phonology, respectively (cf. Stoel-Gammon, 1987; Schwartz & Leonard, 1982). Thus, this elicited sample was collected to ensure a representative sample of each child's speech.

Table 1. Participant characteristics at initial observation.

Subject	*Age in months*	*Number of different words*	*Word combinations*
YC1	22	20	Yes
YC2	22	30	No
OC3	31	9	No
ON4	31	47	No
ON5	30	42	Yes

The verbal utterances of the children obtained at each recording session were transcribed phonetically by three graduate students in speech and hearing sciences. All transcribers were trained in transcription review procedures and individually transcribed a sample tape from a typically developing toddler in order to develop procedural uniformity. Broad phonetic transcription was used with minimal phonetic detail (cf. Shriberg & Lof, 1991). Transcribers were allowed to review audio- and videotapes as often as needed to transcribe the utterances. Children's vocalizations were transcribed following procedures similar to those described by Stoel-Gammon (1989). Transcription reliability was calculated on 25% of the total transcripts. Point-by-point consonant comparisons were made and interjudge reliability ranged from .80 to .95, with a mean of .85.

Similar to the Stoel-Gammon (1989) study, only meaningful vocalizations were included in the data analyses. Videotapes were viewed to use contextual cues, which would help establish an utterance as a word or nonword. Unlike the Stoel-Gammon study, however, there was no upper limit placed on the number of vocalizations transcribed within the 30–40-minute sample.

The children's speech was analyzed in two ways. First, an independent analysis (cf. Stoel-Gammon, 1991) was completed that analyzed each child's sound system as a unique, self-contained system. Second, a relational analysis was completed that compared the child's system to the adult system. These two types of analyses resulted in the following variables examined in each child's speech:

1. Independent phonological analysis
   a. phonetic inventory
   b. syllable structure
2. Relational phonological analysis
   a. PCC (cf. Shriberg & Kwiatkowski, 1982)
   b. sound variability
   c. error patterns

In addition to these phonological analyses, two general measures of language development were examined. Mean length of utterance (MLU) was used as a basic indicator of grammatical development. Lexicon size also was examined as a variable closely related to phonological development. These were determined from the language samples obtained monthly from each child.

The results from the late talkers are reported according to the three primary goals of this investigation: (a) course of phonological development of late talkers, (b) course of

development of specific domains of language, and (c) possible predictors of delay versus deviance.

RESULTS AND DISCUSSION

Course of Phonological Development

The results in this section are reported for each of the measures from the independent and relational phonological analyses. The data will be reported for children in the younger and older groups, as well as with regard to differences across the children that resembled aspects of their phonological skills that appeared to catch up. Finally, the findings will be compared to previous studies that have examined the phonological skills of late talkers and typically developing children.

Phonetic inventory. A phonetic inventory was established for each child from identifiable words at each observation session. To be included in the phonetic inventory, each consonant had to occur in at least two words in the child's speech sample (Stoel-Gammon, 1989). A consonant was included in the phonetic inventory regardless of accuracy relative to the ambient sound system. Phonetic inventories were constructed for WI and WF positions.

The size of the phonetic inventories by word position and total inventory is summarized across children and across time in Table 2. If a language sample was not obtained for a given month, no data were reported for that child, as indicated by blank data cells. It also is important to note that the WI and WF phonetic inventories do not necessarily equal the total inventory because the total inventory represents the number of different sounds produced by the child across both positions.

As seen for the younger children (YC1 and YC2), phonetic inventories included a total of 7 and 8 different consonants for YC1 and YC2, respectively, at 22 months. YC1 demonstrated a more gradual increase in phonetic inventory, with his largest spurt (15 total consonants) occurring at age 31 months. YC2 had faster increases, with his largest spurt (19 total consonants) occurring slightly earlier at 30 months.

The older children (OC3, ON4, ON5) had equivalent (6–8 total consonants) or smaller (4 total consonants) inventories at their first observation (30–31 months) than the younger children did at an earlier age. OC3 experienced the earliest spurt in inventory size at age 35 months, with

Table 2. Total number of phones in phonetic inventory (word initial [WI], word final [WF], and total) for each child at each observation period.

	YC1			*YC2*			*OC3*			*ON4*			*ON5*		
Age	*WI*	*WF*	*Total*	*WI*	*WF*	*Total*	*WI*	*WF*	*Total*	*WI*	*WF*	*Total*	*WI*	*WF*	*Total*
22	6	1	**7**	6	2	**8**									
23	5	0	**5**	8	2	**10**									
24				9	4	**12**									
25	7	1	**8**	8	8	**15**									
26	6	2	**8**	13	9	**17**									
27	7	3	**10**	13	8	**15**									
28	8	5	**11**	14	9	**15**									
29	8	4	**10**												
30	9	6	**10**	16	12	**19**							6	1	**6**
31	12	10	**15**	13	9	**16**	4	0	**4**	8	0	**8**			
32							8	1	**9**	9	4	**10**	6	1	**6**
33	11	12	**18**	14	8	**14**	9	1	**10**	12	4	**12**	8	0	**8**
34							13	5	**13**	10	5	**11**	10	2	**10**
35							15	16	**21**	14	2	**14**	8	1	**8**
36										11	5	**12**	11	2	**11**
37							16	13	**20**				10	2	**11**
38							17	13	**20**	14	8	**16**	11	0	**11**
39							16	13	**21**	13	8	**15**			
40							17	15	**20**				11	4	**12**
41										10	5	**10**			
42							15	16	**20**						

Note. Age is in months.

21 total consonants. ON4 and ON5 never experienced significant increases (i.e., no more than 3–4 additional consonants) throughout the entire study. Furthermore, their largest phonetic inventories remained lower than the largest inventories for the other three children (ON5 = 12 consonants and ON4 = 16 consonants as compared to OC3 = 21 consonants, YC2 = 19 consonants, and YC1 = 18 consonants). This was noted for word position (WI and WF) as well as for overall phonetic inventory sizes. This difference was particularly noteworthy in WF phonetic inventories. ON4 and ON5 never produced more than 8 and 4 different consonants word-finally, respectively.

With regard to types of sounds produced and included in the phonetic inventories, the three catch-up children demonstrated typical but delayed development. YC1, YC2, and OC3 produced primarily voiced anterior stops, nasals, and a glide ([w]) word-initially and either a voiceless fricative ([s]) or voiceless stops word-finally in their early phonetic inventories. Later, they added to existing manner categories by expanding the places of production (i.e., palatal and velar) and by adding new manner categories (i.e., fricatives, affricates, and liquids).

The two non-catch-up children (ON4 and ON5) displayed slightly different developmental paths in phonetic inventory with regard to either place or manner classification of their earlier inventories. For example, ON4's early phonetic inventory consisted of voiced alveolar and palatal stops, nasals, and glides word-initially, to which he later added stops word-finally. He later added affricates [tʃ, dʒ] word-initially and intermittently produced the fricatives [f] word-initially and [z] word-finally during the final observation sessions. ON5 produced nasals and glides word-initially and nasals word-finally and later added stops. Fricatives were never acquired during the course of the study, and only the affricate [dʒ] was added word-initially at the end of the study.

Syllable structure. Syllable structures were examined in three ways: (a) preferences, (b) complexity, and (c) diversity. With regard to syllable structure preferences, simple syllable structures such as CV, CVC, and CVCV were preferred syllable shapes for all children at the initial observation periods. Nonfinal consonant syllables were more frequent than syllables with final consonants. Nonfinal consonant syllables were more frequent than final consonant syllables for all children at all ages, with the exception of OC3 at ages 38 and 42 months.

Table 3 lists the first occurrence and frequency of complex syllable structures. Complex syllable structures included syllables with sequential consonant production that occurred in any position (i.e., WI, intervocalic, or WF). First occurrence of a complex syllable structure was determined using similar criteria for constructing phonetic inventories. That is, a complex syllable structure had to occur at least twice in a given position to be counted as a first occurrence. As shown in Table 3, the younger group (YC1 and YC2) first produced complex structures (i.e., consonant clusters) at an earlier age than did the older group (OC3 and ON5). First occurrences of complex syllable productions that occurred during a child's first observation sessions were marked with an asterisk (i.e., YC2 at 22 months and ON4 at 31 months). Given that ON4's first production of a complex syllable occurred during his first observation session, it is only possible to state that his first production of consonant clusters occurred *at least* as early as 31 months. Similar to typical development of complex syllable production, the first occurrences appeared postvocalically for all children with the exception of ON4.

With regard to frequency of occurrence of complex syllable structures, two interesting patterns were noted. First, both children in the younger group produced more complex syllables, as indicated by the range and mean,

Table 3. First occurrence and frequency of complex syllable structures.

	Younger group (22–23 months)		*Older group (30–42 months)*		
	YC1	*YC2*	*OC3*	*ON4*	*ON5*
Age at first occurrence ≥ 2X	25 months	22 months*	32 months	31 months*	35 months
Position of first occurrence	postvocalic	word initial and postvocalic	postvocalic	word initial	postvocalic
		Range (Frequency)			
Word initial	1–6	2–16	1–23	1–4	1–2
Postvocalic	1–9	3–21	4–63	1–2	1–2
		Mean (Frequency)			
Word initial	1.8	6.2	7.0	1.33	.75
Postvocalic	3.1	10.45	16.8	1.56	.75
Overall mean	2.45	8.33	11.9	1.45	.75

*Denotes occurrence was during the first observation period.

than either ON4 or ON5 in the older group. ON4 produced 1–4 complex syllables word-initially and 1–2 complex syllables word-finally across all observation sessions. ON5 only produced 1–2 complex syllables in any position during the entire study. Complex syllable structure (overall) ranged from 5.4 different complex syllables produced by the younger group and 4.7 produced by the older group. Thus, although 8–11 months older, the children in the ON group actually produced fewer complex syllables than did children in the YC group. The second interesting pattern was the higher frequency of complex syllables postvocalically, which is consistent with typical development. This pattern, however, was not evident for either ON4 or ON5, in which there was little or no difference in mean frequency of complex syllable production across word positions.

Table 4 examines the diversity of syllable structures produced by all the children. This table represents the number of different syllable structures produced at least two times by each child. As shown in this table, ON4 and ON5 had the least diverse syllable structure production even at an older age than did YC1 and YC2, who were at a younger age. The YC group produced an average of 9.2 different syllable structures across the observation periods from 22–33 months as compared to an average of 7.5 different syllable structures produced by the ON group from 30–41 months.

PCC. A relational analysis of the accuracy of the children's utterances, PCC (Shriberg & Kwiatkowski, 1982), was calculated for each observation. Because PCC can be influenced by other factors, this metric also was examined in relation to other variables, such as number of different words produced by each child in each observation session and the MLU. Table 5 summarizes these variables for each child at each observation period. As expected, the number of different words produced and the MLU increased concomitantly with an increase in PCC. The younger group produced an equivalent or higher MLU (i.e., MLU of 1.6 and 3.0) than did the older group at the same age (i.e., MLU of 1.8, 1.8, and 1.5).

With regard to PCC, two general patterns of typical development were noted. First, WI PCC tended to be higher than WF PCC across all observation periods. Second, PCC generally increased over observation periods. More interestingly, however, is the comparison of PCC for the younger group versus the older group. The younger group had a higher PCC at earlier ages than did the older group, especially for ON4 and ON5. For ON5, there was a small range of PCC across all observation periods (.23–.33), demonstrating little change in accuracy of her productions. WF PCC for both ON4 and ON5 also was consistently much lower throughout the study as compared to that of the other 3 children.

Variability in sound production. Similar to Vihman and Greenlee's (1987) measure of variability of word production, a metric was developed to evaluate variability specifically in sound production. Based on consonants that were produced more than once for a given target sound in meaningful words, a ratio was calculated in which the total number of different consonants *attempted* during an observational session was divided by the total number of different consonants *produced*. The number of attempted consonants was obtained by comparison to the adult target.

$$\text{Sound Variability} = \frac{\text{number of different consonants attempted}}{\text{number of different consonants produced}}$$

In this way, variability in sound production was calculated as a ratio between number of different consonants attempted and actual number of different consonants produced. No variability in consonant production would result in a 1:1 correspondence between consonants attempted and consonants produced, or a ratio of 1.0.

Greater sound variability would result in a many-to-one correspondence in which the ratio is below 1.0. In this instance, the child would produce a single target sound with several different consonants. Two examples might help illustrate this sound variability metric (SVM). OC3 at 33 months had an SVM of .80, which indicated some variability in her sound productions. For example, she produced /t/ as [t, ʔ]. ON5 at 33 months had an SVM of .34, which indicated greater sound variability in her sound productions. For example, she produced /t/ as [t, w, tʃ, d, dʒ].

ON4 and ON5 maintained greater variability throughout the study, with overall variability ratios that were generally higher at 40–42 months than the other 3 children had at 22–24 and 31–33 months. Further, ON4 and ON5 had less change in variability across time than did the other 3 children. This suggests that they had consistently less stable phonological systems at any time than the other children.

This variability metric provides a rough indication of variability in sound production and should be used with an understanding of its limitations. It should be examined in conjunction with inspection of the actual types of errors the

Table 4. Average syllable diversity.

	Younger group (22–23 months)		*Older group (30–42 months)*		
	YC1	*YC2*	*OC3*	*0N4*	*ON5*
Range (# of different syllable structures)	5–11	6–17	3–22	7–10	3–10
Mean	7.40	10.91	12.50	8.67	6.30

Table 5. Number of different words produced, percentage of consonants correct (PCC), and mean length of utterance (MLU) for each child at each observation period.

Child	Age (months)	No. of different words	PCC	MLU
YC1	22	21	.20	1.4
	23	24	.37	1.1
	25	34	.42	1.4
	26	39	.41	1.2
	27	48	.47	1.6
	28	86	.44	1.4
	29	63	.57	1.5
	30	74	.57	1.7
	32	138	.39	1.9
	33	63	.63	1.6
YC2	22	30	.27	1.4
	23	32	.46	1.1
	24	39	.59	1.7
	25	59	.49	1.5
	26	85	.44	2.4
	27	112	.58	2.2
	28	153	.39	2.4
	30	179	.50	3.2
	31	139	.48	3.1
	32	202	.59	3.2
	33	138	.63	3.0
OC3	31	9	.74	1.1
	32	40	.47	1.4
	33	62	.48	1.8
	34	66	.56	1.4
	35	121	.83	2.3
	37	156	.69	3.1
	38	179	.85	3.3
	39	183	.66	3.1
	40	224	.92	3.5
	42	179	.88	3.8
ON4	31	47	.29	1.6
	32	108	.44	1.6
	33	106	.35	1.8
	34	111	.37	1.6
	35	154	.29	1.8
	36	123	.35	1.8
	38	135	.51	2.6
	39	138	.56	2.6
	41	188	.37	3.4
ON5	30	44	.29	1.6
	32	41	.33	1.5
	33	66	.29	1.5
	34	55	.24	1.3
	35	58	.23	1.7
	36	117	.23	1.5
	37	110	.24	1.7
	38	110	.25	1.6
	40	133	.32	1.6

child produced in order to determine if the metric is a true reflection of free variation.

Error patterns. Table 6 summarizes the phonetic inventories and substitution errors produced by each child at two points in time. For the younger group, the age periods were 22 and 33 months. For the older group, the age periods were 33 months and 41–42 months. Thus, comparison across all 5 children was possible at 33 months. Each child's phonetic inventory was compared to Prather, Hedrick, and Kern's (1975) developmental norms using the 50% criterion level at ages 22 months, 32 months, and 40 months. Comparison to these developmental norms revealed the number and specific sounds missing from each child's phonetic repertoire at the specified ages.

Error analyses of each child's sound system relative to the adult target were completed on identifiable words at the two time periods. Examination of the errors produced by the children revealed that all children frequently produced errors of omission and substitution. The types of substitution errors involved primarily errors of place and manner, with place errors being slightly more frequent. Beyond this general trend, the children were differentiated in terms of *frequency* and *type* of errors. With regard to errors of substitution, ON4 and ON5 produced more errors than the other children did. For example, examining all children at 33 months, YC1, YC2, and OC3 produced 9, 11, and 4 substitution errors, respectively, as compared to 14 and 12 produced by ON4 and ON5. Further differences were noted when examining the *type* of substitution errors produced. ON4 and ON5 produced several atypical substitution patterns, such as d/h and dʒ/t, whereas the other children produced more common substitution error patterns (cf. Byrne & Shervanian, 1977; Cairns, Cairns, & Williams, 1974), such as gliding (w/r) and fronting (d/g). As noted in Table 6, the sounds that YC1, YC2, and OC3 produced in error involved later developing sounds, such as [tʃ, l, ð, r], as compared to early developing sounds that were frequently produced in error by ON4 and ON5, such as [p, t, d, m, h]. Finally, ON4 and ON5 consistently exhibited more errors of omission than the other children did, even at older ages as compared to YC1 and YC2 at earlier age periods.

Specific Domains of Language Development

Two general measures of language development were examined. MLU was used as a basic indicator of grammatical development. Lexicon size also was examined as a variable closely related to phonological development. These were determined from the language samples obtained monthly from each child.

As indicated previously in Table 5, the number of different words produced by each child, as well as the MLU obtained across the ages observed, are summarized. Compared to lexicon size of typically developing children, all 5 children were significantly below the average lexicon size reported by Stoel-Gammon (1989) of 53.8 different words at 24 months. For the younger group, YC1 and YC2 had an average lexicon size of 23 and 34 words during the 22–24-month observation period. These children's lexicon size was more equivalent to that of the younger typically developing children reported by Vihman and Greenlee (1987), who at 15–18 month of age had 25 words. Even the children in the older group were significantly below this lexicon size at the 31–33-month observation period. With the exception of ON4, who had an average lexicon size of 87, the other two children produced 37 and 54 different words at 31–33 months. As stated previously in

Table 6. Comparison of children's phonological systems across two observation periods.

Subject	*Age*	*Phonetic inventory*	*Norms*[a]	*Substitutions*	*Age*	*Phonetic inventory*	*Norms*[b]	*Substitutions*	*Age*	*Phonetic inventory*	*Norms*[c]	*Substitutions*
YC1	22	m n b d kg w	5 (ŋ,p,t,f,h)	dʒ→g k→g ð→d l→w˜b	33	m n ŋ pb td tʃ dʒ kg f sz ʃ w l r	2 (j,h)	r→r˜w tʃ→tʃ˜d k→k˜d ʃ→ʃ˜d˜l g→g˜d ŋ→ŋ˜n s→s˜l f→f˜b θ→θ˜s˜f				
YC2	22	m n b ʔ s ʃ w r	5 (ŋ,p,t,f,h)	t→t˜d˜ʔ dʒ→d ð→ð˜d z→s	33	m n pb td θ s ʃ h w l r j	4 (ŋ,k,g,f)	s→s˜θ˜ʃ ʃ→ʃ˜θ tʃ→tʃ˜ʃ r→r˜w k→t l→l˜w˜d g→d ð→d f→f˜s˜θ z→z˜s ŋ→n				
OC3					33	m n pb d g ʔ f h w j	6 (t,k,s,ŋ,r,l)	ð→d r→w t→t˜ʔ k→ʔ	42	m n pb td tʃ dʒ kg tv ðsz ʃ h w l r	2 (ŋ,j)	tʃ→tʃ˜s ŋ→ŋ˜n g→g˜k ð→ð˜d˜l ʃ→ʃ˜s l→l˜w r→r˜w θ→θ˜f
ON4					33	m n pb td tʃ dz ʔ s h w j	6 (ŋ,k,g,f,r,l)	p→p˜b t→t˜h˜d tʃ→d dʒ→d k→d g→d f→t˜d θ→d˜t˜ʃ ð→d ʃ→t s→d˜h m→m˜d h→h˜d r→w	41	m n pb td tʃ h w j	9 (ŋ,dʒ,f,v, s,z,ʃ,l,r)	m→m˜n n→n˜d t→t˜d˜f tʃ→d dʒ→t k→k˜d˜g f→t˜d˜k˜g˜b ð→ð˜d ʃ→g˜dʒ s→k˜d˜t l→l˜w
ON5					33	n pb td dz ʔ h w j	8 (m,ŋ,k,g, f,s,r,l)	p→p˜b t→t˜w˜tʃ˜d˜dʒ d→d˜dʒ tʃ→tʃ˜dʒ˜t˜ʔ k→dʒ˜d˜t˜ʔ g→d˜t f→b s→dz˜t˜d˜ts˜ʔ r→w˜n l→j˜n ʃ→tʃ˜dʒ˜d˜s˜ʔ z→d	41	m n pb td ts tʃ dʒ kʔ s h w r j	9 (ŋ,l,g,tʃ, f,v,z,s,ʃ)	ŋ→n˜d k→t˜tʃ˜ts b→b˜p˜t g→t˜d˜θ d→d˜t f→p˜b tʃ→tʃ˜t θ→t˜p˜b dʒ→t s→s˜t˜tʃ˜dʒ˜d˜h˜ts z→t˜s ʃ→t n→n˜m r→r˜w˜m p→p˜t l→l˜j˜w˜d˜n˜r v→b ð→d˜j˜tʃ˜w˜t˜n˜h m→m˜n t→t˜p˜d j→j˜n h→h˜ts w→w˜n

[a]Number of sounds produced by 50% of children at age 22 months according to developmental norms (Prather, Hedrick, & Kern, 1975). [b]Number of additional sounds produced by 50% of children at age 32 months. [c]Number of additional sounds produced by 50% of children at age 40 months.

the selection criteria, a restricted lexicon was a criterion for participation in the study.

Three of the 5 children exhibited improving MLU scores whereas 2 children, YC1 and ON5, showed little to no improvement. Again, compared to Stoel-Gammon's (1989) average MLU of 1.90 at 24 months, children in the younger group had MLUs of 1.25 and 1.4 at 22–24 months and children in the older group had MLUs of 1.43, 1.66, and 1.50 at the 31–33-month level. By the end of the study, the MLU for YC1 and YC2 was 1.6 and 3.0 at 33 months. For OC3, ON4, and ON5, their final MLU was 3.8 (at 42 months), 3.4 (at 41 months), and 1.6 (at 40 months), respectively. With the exception of YC1 and ON5, the current children had a higher MLU than the late talker group at age 3 in the Roberts et al. (1998) study. Specifically, Roberts et al. (1998) reported an MLU of 2.41 for their 3-year-old SLI-E group and an MLU of 4.14 for their typically developing group.

Comparison of results to typical development and previous studies on late talkers. A comparative summary of the different variables examined through independent analyses and relational analyses to available data for typically developing children is provided in Tables 7 and 8.

In Table 7, the phonetic inventory data are summarized for each child for the first and last observation periods and compared to data from Stoel-Gammon (1987) and Dyson (1988). Comparison to Stoel-Gammon's data on 24-month-old typically developing children indicates that all of the children in the younger group of the present investigation had smaller inventories at the beginning of the study. According to Stoel-Gammon, the typical 2-year-old had an inventory of 9–10 different WI consonants and 5–6 different WF consonants. In contrast, the 2 children in the younger group (YC1 and YC2) produced 6 WI consonants and 1 and 2 WF consonants, respectively. However, by the end of the study, YC1 and YC2 produced 11 and 14 WI consonants and 12 and 8 WF consonants, respectively, at 33 months.

Comparison of the children in the older group to Dyson's (1988) children at 39 months again reveals smaller inventories. Dyson reported WI and WF inventories of 15 different consonants. For the children in the older group, only OC3 matched this inventory size at 39 months, with 16 WI and 13 WF consonants (see Table 2). For OC3, this represents a substantial increase from 4 WI and 0 WF consonants at 31 months as she filled in the gaps during that time period. The other 2 older children did not demonstrate this type of "growth spurt" in phonetic inventories. ON4 had 10 WI and 5 WF consonants at 41 months, whereas ON5 only produced 11 WI and 4 WF consonants at 40 months.

Rescorla and Ratner (1996) compared the phonetic inventories of two groups of 24–30-month-old children: typically developing children and children with SLI-E. They reported that the SLI-E children produced an average of 8.6 different consonants whereas their typically developing peers produced 17.4 consonants. In comparison to the phonetic inventories of the late talkers in the present study, the children in the younger group fell between the SLI-E and typically developing children, with an average consonantal inventory of 9.5 and 15.5 different phones (averaged total inventory between 24–30 months). Although the 3 children in the older group were older than Rescorla and Ratner's children, their phonetic inventories at 30–31 months included an average of 6–9 consonants, which was less than the SLI-E children at a younger age.

Regarding syllable structure, Pharr et al. (2000) found that typically developing children at 24 months produced Level 3 syllable structures most frequently (i.e., syllables containing two or more different consonants) as compared to their SLI-E age peers, who produced Level 1 syllable structures most frequently (i.e., V or CV syllables in which

Table 7. Comparison of phonetic inventory and syllable structure of late talkers with typically developing children.

	Phonetic inventory		*Syllable structure*	
Child	*24 months Stoel-Gammon (1987) 9–10 WI 5–6 WF*	*39 months Dyson (1988) 15 WI/WF*	*24 months Pharr et al. (2000) 2 or more different consonants*	*36 months Pharr et al. (2000) 2 different consonants; consonant clusters*
YC1	6 WI / 1 WF (22 months)	11 WI / 12 WF (33 months)	CV; V (22 months)	CV; CVC; CVCVC (33 months)
YC2	6 WI / 2 WF (22 months)	14 WI / 8 WF (33 months)	CV; CVC (22 months)	CV; CVC; CVCV (33 months)
OC3	4 WI / 0 WF (31 months)	15 WI / 16 WF (42 months)	VC; CVCV; CV (31 months)	CVC; CVCV; CVCVC (42 months)
ON4	8 WI / 0 WF (31 months)	10 WI / 5 WF (41 months)	CV; V (31 months)	CV; CVC (41 months)
ON5	6 WI / 1 WF (30 months)	11 WI / 4 WF (40 months)	CV; V (30 months)	CV; CVC; CVCV (40 months)

the consonant is a glide or glottal stop). None of the children in the present study produced Level 3 syllable structures as their predominant syllable structure during the first observation period for either the younger or the older group of children.

By age 36 months, Pharr et al. (2000) found that both groups of children produced Level 3 syllable structures most frequently, although typically developing children produced a slightly greater proportion of Level 3 syllable structures and consonant clusters (Level 4). In comparison to the present study, although none of the 3 catch-up children (YC1, YC2, OC3) produced Level 4 structures within their predominant syllable structures, all produced Level 3 syllable structures.

Dyson (1988) reported that typically developing children, aged 33–39 months, produced 10.7 different clusters. ON4 and ON5 were significantly below this average at 1.45 and .75 different clusters produced between 30–42 months of age. Only OC3 in the catch-up group produced 11.9 different clusters during the same age period.

Compared to Rescorla and Ratner's (1996) two groups of children (SLI-E and typically developing) at 24–30 months of age, 3 of the late talkers (YC1, YC2, OC3) were similar to the typically developing children with regard to syllable preferences for CV and C_1VC_2. The 2 other children, ON4 and ON5, still demonstrated syllable preferences for CV and V at 30–31 months, which is similar to the SLI-E children at an earlier age.

Table 8 provides a comparative summary of the relational analysis variables to existing data for typically developing children. Comparison of the late talkers to Stoel-Gammon's (1987) PCC results of .70 for typically developing 24-month-olds indicates that these children's PCC scores are lower (.20 and .27 for the younger group at 22 months and .47, .29, and .29 for the older group at 30–32 months). As indicated in Table 8, the 3 catch-up children made larger gains in PCC (.63–.88) at the end of the study, whereas little change was observed for the 2 non-catch-up children (.37 and .32) by the end of the study. Paul and Jennings (1992) reported a PCC of .74 for their 24–34-month-old typically developing children, which is similar to the PCC obtained by the catch-up children in the present study. In another study, Roberts et al. (1998) reported PCC scores of 68.3 and 57.4 for their 3-year-olds in the late bloomer and continuing delay groups, whereas their typically developing peers at age 3 had a PCC of 89.4. In comparison, the 3 catch-up children in the present study had PCC scores similar to the late bloomer group and the 2 non-catch-up children had much lower PCC scores than the continuing delay group.

Vihman and Greenlee (1987) examined measures of variability in typically developing children at age 1. Specifically, they examined phonological stability (proportion of consonant productions that were marginal phones, i.e., sounds produced with limited frequency) at the 15-word stage, which corresponded to an average age of 15 months. They found that stability of consonantal production was less than 50%, which indicates that more than half of the children's consonantal productions were marginal phones. Their second measure involved variability in consonantal production relative to selectivity of preferred consonants. Based on this measure, Vihman and Greenlee's results indicate that variability of preferred sounds was more of the free variation type. Free variation is the inconsistent and unpredictable production of a given sound.

Although a direct comparison cannot be made between the variability measure computed in this study with that of Vihman and Greenlee's (1987) typically developing children, the present data indicate that ON4 and ON5 demonstrated phonological organizations that were more reflective of the less stable and more variable sound

Table 8. Comparison of percentage of consonants correct (PCC), sound variability, and error patterns of late talkers versus typically developing children.

	PCC		*Sound variability*		*Error patterns*	
	Stoel-Gammon (1987) .70	*Paul & Jennings (1992) .74*	*Vihman & Greenlee (1987) Free variation*	*No reported comparative data*	*Dyson & Paden (1983) 50% del / 54% sub*	*Dyson & Paden (1983) 30% del / 48% sub*
Child	*(24 mo)*	*(24–34 mo)*	*(15 mo)*		*(23–25 mo)*	*(29–41 mo)*
YC1	.20 (22 months)	.63 (33 months)	1.81 (22 months)	1.12 (33 months)	54% del / 46% sub (22 months)	25% del / 74% sub (33 months)
YC2	.27 (22 months)	.63 (33 months)	1.41 (22 months)	1.23 (33 months)	37% del / 59% sub (22 months)	33% del / 66% sub (33 months)
OC3	.47 (32 months)	.88 (42 months)	1.44 (31 months)	.93 (42 months)	63% del / 35% sub (31 months)	17% del / 78% sub (42 months)
ON4	.29 (31 months)	.37 (41 months)	2.07 (31 months)	1.90 (41 months)	36% del / 64% sub (31 months)	43% del / 55% sub (41 months)
ON5	.29 (30 months)	.32 (40 months)	1.41 (30 months)	1.44 (40 months)	53% del / 47% sub (30 months)	43% del / 57% sub (40 months)

Note. Del = deletions; sub = substitutions.

systems of the younger children, as evidenced by the higher incidence of free variation.

In comparing the error patterns produced by typically developing children, Preisser, Hodson, and Paden (1988) reported that children 22–25 months of age produced more deletion or syllabic simplification processes (cluster reduction = 76%) as compared to substitution or structural simplification processes (liquid deviation = 75%). This proportion of deletion to substitution changes shifted with age to 51% deletion and 64% substitution at 26–29 months of age. Similar findings were reported for older typically developing children by Dyson and Paden (1983). They reported 50% deletion/54% substitution at 23–35 months and 30% deletion/48% substitution processes at 29–41 months of age. This pattern was observed for 3 of the late talkers (YC1, YC2, OC3). Specifically, YC1 and YC2 produced an average of 45.5% deletion processes at 22 months and dropped to 29% deletion processes at 33 months. OC3 produced 63% deletion processes at 33 months and dropped to 17% deletion processes at 42 months. Conversely, ON4 and ON5 produced an average of 45% deletion processes at 33 months and 43% deletion processes at 41 months.

Examination of the phonological process data in the Roberts et al. (1998) study indicated that their 3-year-old SLI-E group produced 40.5% deletion/24.6% substitution processes and their typically developing comparison group produced 43.4% deletion/57.9% substitution processes at the same age. Although Roberts et al. found no significant differences between the two groups of children in the occurrence of phonological processes, the SLI-E group produced more deletion processes in relation to substitution processes, similar to ON4 and ON5. Conversely, the typically developing group produced more substitution processes than deletion processes, which was similar to the 3 catch-up children (YC1, YC2, and OC3).

Stoel-Gammon (1991) described another aspect of atypical error patterns in terms of a chronological mismatch in which a child produces errors on early developing sounds. Typically, errors are produced on later developing sounds. As noted above, this chronological mismatch pattern was observed for ON4 and ON5.

Possible Predictors of Phonological Development

General trends and individual outcomes. The findings from this study revealed that 3 of the 5 late talkers resolved their late onset of phonological development by 33 months of age for the younger group (YC1 and YC2) and 35 months for OC3, who was from the older group. Forty percent of the sample (ON4 and ON5) still had delayed/deviant phonological systems at 40–41 months of age. The 60% recovery rate in this study is in line with that reported in Paul's (1989) study, which indicated that 59% of toddlers who were delayed in speech at age 2 had good outcomes at age 3.

The fact that 3 out of 5 of the children in this study had relatively good phonological outcomes by age 3 should be considered within the context of the study. The children's participation in the present study on a monthly basis could have facilitated their outcomes. The monthly observations may have provided additional language stimulation for the children. The parents participated in the observations, which also may have facilitated parent–child interactions that were beneficial to their child's speech and language development. However, this recovery rate also is similar to that reported by Ellis Weismer et al. (1994), in which 3/5, or 60%, of the late talkers evidenced recovery. Similar to the possible influences in this study of increased interactions (monthly clinic observations) and potentially improved parent–child interactions, the children in the Ellis Weismer et al. study received early intervention services that likely boosted their language abilities.

A possible factor that may account for the fact that 2 children did not evidence spontaneous remission is that they were not identified as late talkers until age 30 and 31 months. Rescorla and Schwartz (1990) and Mirak and Rescorla (1998) suggested that the likelihood of a child "outgrowing" his or her delay decreases if the child is 30 months old when first diagnosed with a delay. Of the 3 older children in this study, only 1 (OC3) evidenced spontaneous recovery. Thus, only 33% of the older toddlers had a positive phonological outcome by age 3. Another important factor in the continued delay with ON4 and ON5 was the fact that both children had histories of otitis media. This is particularly noteworthy in that these were the only children in the study with histories of frequent ear infections.

Possible predictors: Delay versus deviance. The independent and relational phonological analyses revealed some interesting differences across the children. These differences revealed certain general patterns that formed a cluster of behaviors that appeared to distinguish the children into two groups on the basis of delayed versus deviant phonological development. Based on quantitative and qualitative differences, Table 9 summarizes a cluster of behaviors that were identified as potential predictors of long-term phonological delay.

This study provided a preliminary examination of several variables that may contribute to our understanding of which children will resolve their phonological delay and which ones will require intervention to catch up. Based on the findings from this study, quantitative and qualitative variables were identified that might be predictive of the late talkers' phonological skills at 33 months of age. Thirty-three months was the age at which the groups began to become differentiated when comparison across all children was possible. In addition to the quantitative differences identified in late talkers, such as smaller phonetic inventories, less diverse and complex syllable structures, and lower PCC scores, this study identified qualitative variables that also appeared to be important in predicting phonological outcomes at 33 months. These included sound variability, atypical error patterns, and little change in development across time. These variables may have been present earlier but were not detected because of the age differences of the participants in the sample. However, these variables were prevalent for 2 children from the older group.

Table 9. Quantitative and qualitative variables of potential long-term phonological delay.

Variable	*Description*
Limited phonetic inventory	At 32 months, 6–9 different WI consonants; 1–4 different WF consonants
Limited diversity of syllable structures	Average of 7.5 different syllable types produced from 30–41 months
Simple syllable structures	Average frequency of 1.1 complex syllables produced from 30–41 months
Greater number of sound errors	PCC < .45 at 33 months
Chronological mismatch	Error productions occurred on early, as well as later, developing sounds
Greater variability and inconsistent substitution errors	A single target phone is produced in a variety of ways
Atypical error patterns	Unusual or atypical phonological processes
Slower rate of resolution	Limited change observed across all domains of phonological development

Note. WI = word initial; WF = word final; PCC = percentage of consonants correct.

Rescorla and Schwartz (1990) and Mirak and Rescorla (1998) reported that the probability of a good prognosis for recovery of SELD went down with the older child and the larger the developmental lag at the time of diagnosis of SELD. In addition to the older age at diagnosis and greater developmental gap, this study also identified qualitative variables that also may be predictive of the late talkers' phonological skills by age 3.

CONCLUSIONS

Prospective longitudinal data on 5 late talkers provided information about the course of phonological development, which in turn helped to identify possible predictors of delayed versus deviant development. Individual outcomes indicated that qualitative differences, in addition to quantitative differences, were important predictors of phonological development. These differences included rate of resolution, sound variability, and atypical error patterns.

These data indicate that significant improvements were noted in the quantitative aspects of phonological and language skills, such as inventory size, lexicon size, and MLU, as individual children got older. However, these variables alone were not diagnostic markers for identifying delayed versus deviant development. Moreover, the fact that these areas appeared to develop in tandem reflects the link between an expanded sound inventory and its influences on the lexicon and MLU. Qualitative differences (i.e., greater variability in sound production, unusual sound errors, and rate of resolution) in the children's phonological development were identified as additional potential markers of long-term language delay. Certainly, the extent of the delay was associated with the children who did not catch up, but the qualitative differences also appear to be strong predictors of eventual outcome. These preliminary results may indicate that not all late talkers have delayed rather than deviant phonological skills, contrary to previous findings (cf., Mirak & Rescorla, 1998; Rescorla & Ratner, 1996; Roberts et al., 1998).

Although these results have clinical application for the assessment and prognosis of late onset of speech, they must be considered as another piece of the puzzle in this area of research. This study provided a focused examination of phonological development that provided an in-depth investigation of productive phonological skills. Limited information, however, was provided on the expressive language abilities of the children, and no information was provided on the children's comprehension abilities. Additionally, no information was obtained on potential family factors that may be a contributing variable to late onset of speech (cf. Ellis Weismer et al., 1994). Further, the role of otitis media cannot be underestimated as an important variable in phonological outcomes. The 2 children who did not resolve their phonological delay were the only children in the study with a history of middle ear infections. Finally, a larger sample of late talkers may provide additional insights into the course and resolution of delayed/deviant phonological development.

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Contact author: A. Lynn Williams, PhD, Department of Communicative Disorders, P.O. Box 70643, East Tennessee State University, Johnson City, TN, 37614. E-mail: williamL@mail.etsu.edu